I. C. 7008

April 1938

UNITED STATES
DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary

BUREAU OF MINES
John W. Finch, Director

INFORMATION CIRCULAR

VERDE ANTIQUE

BY

Oliver Bowles and Florence Davidson

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By Oliver Bowles[2] and Florence Davidson[3]

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INTRODUCTION

Marble is one of the most beautiful and enduring materials employed in the construction industries. Because of its diverse colors, decorative patterns, and varying textures, it has furnished material for artistic architectural design for many centuries.

The marble industry is described in some detail in Bureau of Mines Bulletin 106, The Technology of Marble Quarrying, which, unfortunately, is now out of print but may be consulted at most large libraries. Onyx marble and travertine are discussed in Bureau of Mines Information Circular 6751. The purpose of this paper is to describe the main features of a distinctive group of ornamental marbles known as the serpentine marbles or verde antiques.

DEFINITION

Verde antique is defined as a green rock consisting essentially of massive serpentine capable of taking a polish and usually crisscrossed or mixed irregularly with white, brown, black, yellow, or red veins or masses consisting of calcite, dolomite, magnesite, iron oxides, and other minerals. It may be defined more briefly as a veined serpentine marble. The term is not confined to marbles of any one district. It was applied originally to the serpentine marbles of Greece, Italy, and Egypt and is now used to designate similar marbles occurring in any locality.

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7008."

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COMPOSITION AND ORIGIN

The essential constituent of verde antique is serpentine, a hydrous, magnesium silicate ($H_4Mg_3Si_2O_9$). The name "serpentine" is derived from the Latin word "serpens", a serpent, in allusion to the serpentlike colors and to their spotted or mottled arrangement. The terms "ophicalcite" or "ophimagnesite" are also applied to marbles consisting of mixtures of serpentine and calcite or serpentine and magnesite, respectively, the prefix "ophis" being the Greek for serpent.

Serpentine is a secondary mineral resulting chiefly from alteration of basic igneous rocks such as peridotites. Any silicate rich in magnesium, such as olivine, pyroxene, and hornblende, may alter to serpentine. Some deposits, however, owe their origin to a less direct process involving metamorphism and crystallization of impure magnesium limestone, and subsequent alteration of the magnesium silicate minerals developed in the crystalline marble.

Although serpentine is a product of alteration of other minerals, it is not the final product of metamorphism; it commonly alters to brucite, magnesite, or hydromagnesite. Some types, however, are more resistant to weathering than others. Serpentine evidently originates in different ways. Bain,[4] who has made a detailed study of the Vermont serpentines, claims that a red-weathering type, which alters and decomposes easily when exposed to the weather, is autometamorphic; that is, its alteration was brought about by solutions within the mass or magma itself. Many serpentines that have given poor service as exterior building stones may be of this type. He claims, however, that the verde antique variety, which resulted from regional forces and agencies of later origin, is much more stable and resistant to weathering than the former type. The polished surfaces of some serpentines tend to fade and to become dull and pitted upon exposure, but a number of verde antiques have given satisfactory service even when exposed to the weather for many years.

The serpentinization of verde antique is associated with more or less intensive fracturing. These fractures may be filled with light-colored carbonate minerals, giving a characteristic network of white or varicolored streaks, bands, or lines on a green background.

Most serpentine deposits are massive, but occasionally the mineral assumes a fibrous form known as chrysotile asbestos. The principal asbestos deposits of the world are of this variety.

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[4] Bain, George W., Serpentinization of Vermont Ultrabasics: Bull., Geol. Soc. America, vol. 47, 1936, pp. 1961-1980.

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The association of serpentine with calcite, dolomite, or magnesite is to be expected, partly because many verde antiques have resulted from partial alteration of impure limestones or other carbonate rocks and partly because, in the process of alteration of basic igneous rocks to serpentine, carbonates are formed as byproducts. Thus, olivine alters to serpentine and magnesite.

The contrasting minerals are associated in different ways. In some types of verde antique, veins intersecting the serpentine have been filled with dolomite or magnesite. In others, angular fragments of limestone or other rocks are cemented with serpentine, giving a type of brecciated marble. So many beautiful patterns are obtainable that the verde antiques are classed with the more important decorative building stones.

HISTORY

The most famous ancient verde antique was that commonly known as "Thessalian marble" quarried near Larissa in the Province of Thessaly, Greece. It was also known as "Lapis Atracius", named for Atrax, an ancient colony in Thessaly; but this was evidently a misnomer, because Atrax was 10 miles west of Larissa, whereas the marble quarries were about 7 miles northeast of that city near the road leading to the Vale of Tempe. Such error may possibly be attributed to poetic license because the best ancient description of the marble is in a poem by Paul the Silentiary, which, translated, reads:

> "The marble that the land of Atrax yields, not from some upland glen, but from the level plains; in parts fresh green as the sea or emerald stone, or again like blue cornflowers in grass, with here and there a drift of fallen snow, a sweet mingled contrast on the dark shining surface."

This description is fairly accurate, for the rock is described as an ophicalcite breccia composed of angular pieces of both green serpentine and white statuary marble cemented with rock of brighter green. The edges of the snow-white patches are tinted with delicate radiating green fibers. The cementing matrix is of the same fibrous structure and a bluish bloom pervades the surface. Thus, the Thessalian verde antique is exceptionally attractive and can be distinguished easily from all other varieties.

The rock probably was first known to the Romans about 170 B. C., and attained great importance about 127 B. C. with completion, by Lucius Cassius Longinus, the Proconsul, of the famous military road leading to the coast by the Vale of Tempe route. Not less than 10 quarries were worked and produced a variety of beautiful marbles. The magnitude of operations is indicated by the deep furrows cut in the solid rock by wheels of oxcarts on which the blocks were hauled to the Aegean Sea for water transportation to various parts of the Roman Empire, and later to Constantinople, Salonica, Jerusalem, Egypt, and other parts of the ancient world. St. Sophia (Constantinople), St. Mark (Venice), and numerous other temples as well as palaces and many other structures are decorated with this famous marble. Pieces of it are turned up with the plow in the cornfields over ancient Carthage.

The quarries were worked for many years, but when Thessaly was invaded and captured by the Turks, between 1380 and 1400 A. D., knowledge of the location was lost. Because of their pronounced beauty, the marbles were much in demand, and fruitless search was made for the quarries at various times. As no quarry blocks were obtainable, sources of supply were confined to ancient structures in which the marbles had been used. So keen was the demand, that numbers of such structures were destroyed to obtain the highly prized marble blocks, which, to eke out the supply, were sawed into thin slabs.

In 1889 the quarries were rediscovered by W. Brindley, and in 1896 the Verde Antico Marble Co. was formed to work the quarries by modern methods. They are still operated and supply considerable marble for the European trade; but during the past 10 years very little has been imported into the United States, because the price is high and because other verde antique marbles are available in this country. Verde antique marbles from other localities were used in ancient times, but none of them attained the prominence of Verde Antico.

USES

The principal use of verde antique is for interior decoration, such as panels, baseboard, floor tile, bank counters, columns, spindles, store windows, tabletops, and mantels. It is used, also, for exterior decoration, particularly for store fronts, but great care should be exercised in selecting for outside use only the varieties that have been proved resistant to weathering agencies.

Many verde antiques are unsound in the sense that they consist of fragments or masses more or less firmly cemented together, and they may be too weak for use as load-bearing units. By careful selection, however, large masses may be found in which the veins are so firmly cemented that the rock is as strong as a homogeneous marble, and such blocks are especially valuable for making ornamental columns and other massive structures.

Verde antique is used for making inkwells, pen sets, paper-weights, clock cases, lamp bases, ashtrays, and various other novelties.

Waste fragments may be crushed to gravel sizes for use in terrazzo floors, stucco, or pebble-dash; also as granules for surfacing prepared roofing.

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PRODUCTION

Domestic

Serpentine occurs in many localities, but only in certain places is it attractive enough or obtainable in blocks sound enough to merit classification as verde antique. It has been produced commercially chiefly in four States - Georgia, Maryland, Massachusetts, and Vermont. It is quarried in much the same way as other varieties of marble, but, because of its unsoundness and its variation in character from point to point, methods must be modified to suit prevailing conditions. Joints usually are less systematic in arrangement than in the white marbles, and large, sound blocks are more difficult to obtain.

Georgia. - The Georgia Marble Co. produced verde antique about 2 miles southwest of Hollysprings, Cherokee County, Ga., for many years but has not operated the quarry recently. The rock occurs in a lenslike deposit about 600 feet long, with a maximum width of about 150 feet. Numerous veins intersecting the massive serpentine make it highly ornamental. They are of two kinds. A network of narrow veins ranging from mere hair lines to 1/2 inch in width and filled with dark-green serpentine is the most attractive feature of the rock. Larger and more persistent veins up to 5 inches in width are filled with dolomite and talc; these veins are sometimes open and cause much waste. Two types were marketed, a rich dark green and a light green, both of which have attractive patterns.

The prevailing seams or cutters run east and west, and the quarry walls were maintained parallel and at right angles to them. Channel cuts were made north and south, thus crossing the seams, and when the blocks were raised from the floor they separated at the open seams. Solid pieces up to 8 or 10 feet long were obtainable, and such blocks were valuable for making columns. Because of the unsoundness, the proportion of waste was very high, but the rock was so ornamental it commanded compensating high prices. No finishing mill was connected with the quarry.

Maryland. - A large serpentine area extends from the Susquehanna River near the Maryland-Pennsylvania boundary southwestward through Harford and Baltimore Counties, Md. Quarries have been worked in various places, but present production is confined to one large quarry worked by the Maryland Marble Co. at Cardiff. The rock is a very attractive, dark green, veined serpentine. Formerly the chief products were granules, terrazzo, stucco, and sand; and while these are still important, the principal output since 1920 is block marble, which is in demand by architects and builders.

An open-pit quarry was worked for many years and was sunk to a depth of about 150 feet. The early operations were very wasteful because the quarry walls followed a direction intersecting the major joints at an angle of about 45°. Thus, the joints crossed the quarry blocks diagonally, and sound blocks were difficult to obtain. As a result of studying a Bureau of Mines report that emphasized the importance of quarrying in accordance with rock structures, the superintendent changed the direction of the quarry walls so that they were parallel with and at right angles to the major joints. This resulted in more economical working, because sound blocks could be obtained between the joints. Also, as the overburden of inferior rock is very thick, a lateral drift was extended from the open pit, and stone is now removed from underground workings. Primary cuts are made with channeling machines. Unsound blocks are manufactured into floor tile and baseboard in a mill at the quarry, and large, sound blocks are shipped to New York and other cities.

Massachusetts. - In several places on and near Russel Mountain about 4 miles from Westfield, Hampden County, Mass., very attractive verde antique is quarried by Westfield Marble Quarries, Inc. The typical Westfield rock is known as "Black and Green" - a rich dark green, variegated by bright-green spots. It occurs in a 50-foot dike of serpentine, which is regarded as an alteration product of basic igneous rock. Primary cuts are made with channeling machines, and blocks are separated by wedging in drill holes. The quarry is about 75 feet square and 70 feet deep. A small mill was operated many years ago, but now the quarry blocks are sold to companies that have finishing mills.

Other types of verde antique are available nearby. One deposit, development of which is now in prospect, consists of a light-gray rock with green markings. When cut in a certain direction, the markings have the appearance of waving grass.

Vermont. - A deposit of serpentine 50 to 60 feet wide is quarried by the Vermont Marble Co. about 1 mile south of Roxbury, Washington County, Vt., 14 miles southwest of Montpelier. The rock was originally a basic dike, probably consisting of peridotite that has altered to serpentine. Polished surfaces are a rich dark green intersected by a network of veins, some of which consist of white magnesite and others of a mixture of magnesite and serpentine, which gives a light-green color. The color contrasts are exceptionally attractive. The product is sold as "Vermont Verde Antique" and is widely employed for columns, wainscoting, counter tops, and various other decorative uses.

The rock occurs in a series of lenses of uncertain continuity. The proportion of waste is high. It is caused partly by unsoundness and partly by associated talc. Primary cuts are made with channeling machines. Blocks are obtained in several locations on individual ledges. The deposits have been worked for many years. The smaller quarries worked recently furnish rock of a lighter green than that obtained in the original deep quarry.

A more recent development of the company was at Rochester in the extreme northwestern part of Windsor County, where an attractive verde antique was quarried and shipped to finishing mills in rough blocks, but the quarries are now inactive. Verde antique has been quarried also at Proctorsville, southern Windsor County, and in Windham County.

Other States. - The Rock Products Co. of Easton, Pa., at times quarries a light apple-green verde antique of attractive veining about 2 miles from Phillipsburg, Warren County, N. J. It has been used with striking architectural effect as an interior decorative material in a bank building in Easton, Pa., but production has never attained commercial importance.

A type known as "Verdolite", quarried about 2 miles north of Easton, Northampton County, Pa., is described as a mixture of light- and dark-green serpentine containing scattered crystals of rose-colored dolomite. It was used for interior decoration many years ago, but there has been no recent activity.

A verde antique of good quality was quarried in a small way some years ago in Marquette County, Michigan.

A light yellowish-green to deep-green mottled and streaked serpentine marble has been obtained near Victor, San Bernardino County, Calif.

Undeveloped deposits are reported in many localities in several States.

Foreign

The Verde Antico of Thessaly, Greece, mentioned previously, is the most important of all the foreign varieties, although it is not worked extensively today. Not only are the marbles of rare beauty, but they are available in sound blocks of large size.

A study of the quarries enables one to determine the methods pursued by the ancient workers. One of the vertical faces appears as a series of semicircular hollows, each of which evidently was formed during the removal of a monolithic column similar to those of St. Sophia, Constantinople. The rock was chipped away with hand tools until a passage was worked all around the column to the desired depth. The column was then broken loose at the base and lowered to the quarry floor ready for transportation. It is evident, therefore, that the finished columns, when placed in buildings, consisted of materials oriented in the way in which they were in the original deposit, that is, bands or other markings that were horizontal in the quarry were horizontal in the erected column.

When rediscovered, one quarry contained a large block squared up but still attached to the quarry floor. It was probably designed for a sarcophagus similar to three famous tombs in Constantinople, which were made of marble from these deposits. In several workings, saw cuts were found. Some of them appear in the quarry floor below the point where the blocks were wedged off. The methods employed indicate a strong tendency to minimize the weight as much as possible because of the difficulties of transportation with the crude equipment then available.

Another type of Greek marble known as "Vert Tinos", obtained on the Island of Tenos in the Aegean Sea, was sold for a time as the original Thessalian marble, although it differs from it greatly. It is a rich light green with white veins.

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The "Cipolin" or "Cipollino" marbles, having alternate bands of light and dark green, are popular varieties. They are so named because of their resemblance to an onion cut in half. Greek "Cipollino" has been used in cathedrals and public buildings of Europe since the days of the Roman Empire. "Cipolin" quarried at Saillon in the Canton of Valais is the most important marble of Switzerland. The typical Swiss marble consists of a pale-green groundmass with straight, thin veins of deeper green. A variety known as "Rubanne" has heavy veins, and that designated "Grand Antique" has a less pronounced banding. Italian "Cipollino" resembles closely that obtained in Greece. French "Cipolin" marbles, typically white with green stripes, are obtained in at least three localities. Both the French and Italian types are well-known in American markets.

Verde antique obtained in Cornwall, England, is of exceptional beauty. It is described as dark olive green with veins, streaks, and blotches of greenish white, chocolate brown, and blood red. It works easily, takes a good polish, and is obtainable in sound blocks up to 8 feet long and 3 feet thick. It is known as "Cornish serpentine."

The "Royal Connemara" or "Galway Green" of Ireland ranges from light to dark green, sometimes in solid colors but more generally mottled, streaked, and variegated. It is a beautiful stone for interior decoration but suffered a loss of reputation because architects and builders insisted on using it for exterior work, for which it was not fitted.

The "Verde di Genova" from near Genoa, Italy, is a breccia consisting of green, blackish-green, brown, or red serpentine fragments cemented with white or greenish calcite. It has been quarried for many centuries.

Another Italian ophicalcite, "Rosso di Levanto," obtained at Levante near the main road leading from Spezia to Genoa, is also a breccia having fragments of a violet or wine-red color interspersed with green serpentine and crossed with a network of veins of white or greenish-white calcite.

"Vert Maurin" of France consists of dark-green to almost black serpentine intersected with white to pale-green veins.

The above are typical of the better known foreign varieties, but many others are in use.

METHODS OF MANUFACTURE

The fabrication of verde antique into finished products is conducted in much the same way as other types of marble. The quarry block is first placed on a saw bed and sawed into slabs with "gang saws." These consist of a series of soft steel blades set in parallel position in a frame, which has a backward and forward motion. The spacing of the blades governs the thickness of the slabs produced. The abrasive agent consists of sand or steel shot fed to the blades with water.

Slabs from the gang saws are cut to required dimensions with circular saws or silicon carbide wheels. The slabs are then smoothed on a "rubbing bed" consisting of a horizontal circular disk of cast iron revolving at moderate speed. Marble slabs or blocks held on the surface of the revolving disk, to which sand and water are supplied, are worn down to desired dimensions and smoothness.

If a polished surface is desired, it is obtained by guiding over the wetted surface of the stone first a "gritting head", which makes the surface smoother than does sand rubbing, and finally a "buffer head" of felt or other soft material. "Putty powder", consisting of extremely fine-grained tin oxide, is used as abrasive for polishing. Irregular surfaces are rubbed and polished by hand, using silicon carbide bricks, fine sandstone blocks, and felt buffers.

Columns may be turned in a lathe, using a steel cutting tool similar to that employed in a machine shop. The rotating column is then smoothed with fine carborundum powder and polished with pads held against the surface and supplied with putty powder.

Drum column cutters are also used. They consist of rotating circular steel drums equipped with diamond teeth or supplied with steel shot and water. The columns or sections of columns thus prepared are placed in lathes for smoothing and polishing.

Small columns, balusters, and spindles may be cut with carborundum wheels shaped as negatives of the desired form. The stone rotates in one direction and the wheel in the opposite direction.

Carving and lettering may be done with pneumatic or hand tools or by sand-blast methods.

MARKETING

Verde antique marbles have a nation-wide market. Some marble companies fabricate the materials according to the demands of special building contracts. Others sell the marble as quarry blocks to other marble-producing companies or to independent mills.

Blocks of marble or slabs more than 2 inches thick are sold by the cubic foot; slabs 2 inches thick and less are sold by the square foot. Merchantable blocks should be at least 5 or 6 feet long, 3 or more feet wide, and 2 or more feet thick, but because of the difficulty of obtaining sound blocks of verde antique in some localities, smaller blocks are often sold.

PRICES

There are no regular quoted prices for verde antique. Much of it is fabricated on special contracts. The price of that sold as quarry blocks is fixed by individual negotiation. Prices may range from $5 to $7 a cubic foot, or even more, depending upon the size and soundness of the blocks and the attractiveness of the polished surface.

STATISTICS OF PRODUCTION

The Bureau of Mines publishes each year in the MINERALS YEARBOOK statistics of sales, both quantity and value, of all marble produced in the United States, but no attempt has been made to separate the marbles according to color. Hence, no statistics for verde antique are available. It constitutes only a small percentage of total sales.